2 Site Assessment

In this chapter...

Inventory and assessment of:

- *Soil analysis*
- *Hydrologic patterns and features*
- *Native forest and soil conservation areas*
- *Wetlands*
- *Riparian areas*
- *Floodplains*

Comprehensive inventory and assessment of on-site and adjacent off-site conditions are the initial steps for implementing low impact development (LID). The inventory and assessment process provides information necessary to implement the site planning and layout activities (examined in the next chapter) by identifying the current and estimating the pre-disturbance conditions. Specifically, the site assessment process should evaluate hydrology, topography, soils, vegetation, and water features to identify how stormwater moves through the site prior to development. The site design should align roads, lots, and structures and implement construction practices to preserve and utilize these features to retain natural hydrologic functions. In almost all cases, low impact development requires on-site inventory and assessment and cannot be properly planned and implemented through map reconnaissance alone.

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Jurisdictions in the Puget Sound region have various requirements for identification and assessment of site characteristics and site plan development. Some or all of the following existing conditions are included by most local governments for identification and evaluation:

Geotechnical/soils	Streams	Wetlands
Floodplains	Lakes	Closed depressions
Springs/seeps	Other minor drainage features	Groundwater
Existing hydrologic patterns	Slope stability and protection	Geology
Habitat conservation areas	Aquifer recharge areas	Topography
Vegetation/forest cover	Anadromous fisheries impacts	Existing development
Erosion hazard areas	Offsite basin and drainage	Down-stream analysis

(King County, 1998; Washington State Department of Community, Trade and Economic Development, 2003; and Washington State Department of Ecology, 2001)

Inventory and evaluation to successfully implement an LID project will include some or all of the above existing conditions depending on the physical setting and regulatory requirements; however, the objective of the analysis and the level of detail necessary may vary. This section presents six steps in the LID site evaluation process that are essential and will likely require more focused attention than in a conventional project. Management recommendations for wetlands, riparian management areas, and floodplains are provided at the end of each evaluation step. Management recommendations for soils, hydrologic features, and native soil and vegetation protection areas are provided in subsequent chapters focusing on those issues.

2.1 Soil Analysis

LID requires detailed understanding of site soils. In-depth soil analyses in appropriate locations are often necessary to determine operating infiltration rates for two primary reasons: (1) LID emphasizes evaporation, storage, and infiltration of stormwater in smaller-scale facilities distributed throughout the site; and (2) on sites with mixed soil types, the LID site plan should locate impervious areas over less permeable soils and preserve and utilize permeable soils for infiltration.

2.1.1 Inventory and Assessment

Methods recommended for determining infiltration rates fall into two categories:

- Texture or grain size analysis using U.S. Department of Agriculture (USDA) Soil Textural Classification (Rawls survey) or ASTM D422 Gradation Testing at Full Scale Infiltration Facilities.
- In-situ infiltration measurements using a Pilot Infiltration Test, small-scale test infiltration pits (septic test pits), and groundwater monitoring wells.

Grain size analysis and infiltration tests present important but incomplete information. Soil stratigraphy should also be assessed for low permeability layers, highly permeable sand/gravel layers, depth to groundwater, and other soil structure variability necessary to assess subsurface flow patterns. Soil characterization for each soil unit (soil strata with the same texture, color, density, compaction, consolidation and permeability) should include:

- Grain size distribution.
- Textural class.
- Percent clay content.
- Cation exchange capacity.
- Color/mottling.
- Variations and nature of stratification.

(Ecology, 2001)

A few strategically placed soil test pits are generally adequate for initial site assessment. Pit locations are determined by topography, estimated soil type, hydrologic characteristics, and other site features. Consult a geotechnical engineer or soil scientist for initial assessment and soil pit recommendations.

A more detailed soil pit assessment is necessary once the preliminary site layout with location of LID stormwater controls is determined. Specific recommendations for assessing infiltration rates for bioretention areas and permeable paving installations are located in sections 6.1: Bioretention Areas and 6.3: Permeable Paving.

For management of on-site soils, see Section 6.2: Amending Construction Site Soils.

Assessing highly permeable gravel conditions

Special considerations are necessary for areas with highly permeable gravel. Signs of high groundwater will likely not be present in gravel lacking finer grain material such as sand and silt. Test pit and monitoring wells may not show high groundwater levels during low precipitation years. Accordingly, sound professional judgment, considering these factors and water quality treatment needs, is required to design multiple and dispersed infiltration facilities on sites with gravel deposits *(personal communication, Larry West, January 2004).*

2.2 Hydrologic Patterns and Features

Hydrology is a central design element that is integrated into the LID process at the initial site assessment and planning phase. Using hydrology as a design element begins by identifying and maintaining on-site hydrologic processes, patterns, and physical features (streams, wetlands, native soils and vegetation, etc.) that influence those patterns.

2.2.1 Inventory and Assessment

In addition to identifying prominent hydrologic features, additional analysis will likely be required to adequately assess water movement over and through the site including:

- Identify and map minor hydrologic features including seeps, springs, closed depression areas, and drainage swales.
- Identify and map surface flow patterns during wet periods, and identify signs of duration and energy of storm flows including vegetation composition, and erosion and deposition patterns.
- If seasonally high groundwater is suspected and if soil test pits do not provide sufficient information to determine depth to groundwater, map groundwater table height and subsurface flow patterns in infiltration and dispersion areas using shallow monitoring wells. Note: in many sites, shallow hand-augured monitoring wells can be installed at low cost.

The conservation and use of on-site native soil and vegetation for stormwater management is a central principle for an LID design.

For management of on-site hydrologic features see Section 1.4.5: Site Design and Management Strategies, Section 2.5: Riparian Management Areas, Chapter 3: Site Planning and Layout, and Chapter 5: Clearing and Grading.

2.3 Native Forest and Soil Conservation Areas

The conservation and use of on-site native soil and vegetation for stormwater management is a central principle of LID design. Protecting these features accomplishes three objectives: (1) reducing total impervious area; (2) increasing stormwater storage, infiltration, and evaporation; and (3) providing potential dispersion areas for stormwater. In addition to maintaining natural hydrologic processes, forest protection can provide other benefits including critical habitat buffers, open space, and recreation opportunity.

2.3.1 Inventory and Assessment

The following are steps to conduct a basic inventory and assessment of the function and value of on-site native vegetation:

- Identify any forest areas on the site and identify species and condition of ground cover and shrub layer, as well as tree species, **seral stage**, and canopy cover.
- Identify underlying soils utilizing soil pits and soil grain analysis to assess infiltration capacity. See Soil Analysis section above and consult a geotechnical engineer for site-specific analysis recommendations.

Soil surveys and vegetation surveys are necessary to determine baseline conditions, establish long-term management strategies, and determine appropriate application of dispersion techniques if stormwater is directed to the protection area.

For management of native vegetation and soil protection areas see Chapter 4: Vegetation Protection, Reforestation and Maintenance.

2.4 Wetlands

Determining appropriate assessment and management protocols for wetlands requires clear goals and objectives, as well as estimates of pre-development and evaluation of current conditions. Appropriate goals and objectives are determined through

Steep slope and shoreline bluff considerations

Special care must be taken when developing on or near steep slopes, including coastal bluffs, especially those composed of layers of unconsolidated glacial sediment that occur in many areas of Puget Sound. Clearing of vegetation, increasing surface runoff, and hydraulic loading through infiltration of surface runoff can destabilize these areas, and in some cases lead to dramatic slope failures. A detailed analysis of the site's geology and hydrology should be prepared by a qualified professional prior to site clearing and development.

the development application process and involve government permitting entities, consultants, and the developer. Core assessment and management objectives for a project that is in a drainage basin with a wetland designated as high quality and sensitive should include: (1) protect native riparian vegetation and soils; (2) protect diverse native wetland habitat characteristics to support the native assemblage of wetland biota; and (3) maintain or approximate pre-development hydrology and **hydroperiod** within the wetland. Note: Washington State Department of Ecology (Ecology) guidance includes Category 1 or 2 wetlands and Category 3 wetlands that meet most of the criteria in Appendix 1-D of Ecology's 2005 *Stormwater Management Manual for Western Washington* (SMMWW) as high quality and sensitive. If the project is within the drainage area for a wetland that can be considered for structural or hydrological modification then the development may incorporate use of the wetland into the stormwater management strategy. Ecology recommends use of criteria in the 2005 SMMWW Appendix 1-D page D-10 for wetland assessment guidelines.

2.4.1 Inventory and Assessment

The following steps should be used as a starting point to adequately inventory and provide an assessment of wetlands:

- Identify wetland category using local jurisdiction regulations and/or Ecology's *Washington State Wetlands Rating System for Western Washington.*
- If the wetland qualifies for protection:
  - o Measure existing hydroperiods and estimate future hydroperiods resulting from the proposed development.
  - o Identify hydrologic pathways into and out of wetland.
  - o Determine whether the wetland has breeding, native amphibians (conduct survey in spring).

2.4.2 Management

- If the wetland qualifies for protection, utilize LID strategies to increase stormwater infiltration and storage on the project site in order to meet the following guidelines (Azous and Horner, 2001):
  - o The increase or decrease of the pre-development mean monthly water level fluctuations should be maintained to less than 5 inches.
  - o The increase or decrease of 6 inches or more to the pre-development water level fluctuation should be restricted to less than 6 times during an average year.
  - o The duration of stage excursions of 6 inches or more above or below the pre-development water level fluctuations should not exceed 72 hours per excursion.
  - o Total dry period (when pools dry down to the soil surface everywhere in the wetland) should not increase or decrease by more than two weeks in any year.
  - o For priority peat wetlands, the duration of stage excursions above or below the pre-development water level fluctuations should not exceed 24 hours in a year.
  - o For wetlands inhabited by breeding amphibians, increases or decreases in pre-development water level fluctuations should not exceed 3 inches for more than 24 hours in any 30-day period.

- o See Guidesheets 2A through 2D in Appendix 1-D of the 2005 SMMWW for additional criteria.

- Designate buffer widths consistent with best available science (see Washington State Department of Community, Trade and Economic Development *Critical Areas Assistance Handbook*, 2003 and *Citations of Recommended Sources of Best Available Science*, 2002).
- Map wetlands and wetland buffer areas on all plans and delineate these areas on the site with fencing to protect soils and vegetation from construction damage. Fencing should provide a strong physical and visual barrier of high strength plastic or metal and be a minimum of 3 to 4 feet high (see Ecology 2001 SMMWW BMP C103 and C104). Silt fencing, or preferably a compost berm, is necessary in addition to, or incorporated with, the barrier for erosion control.
- Install signs to identify and explain the use and management of the natural resource protection areas.
- See Riparian Management Areas section for additional management strategies within buffer areas.

2.5 Riparian Management Areas

The riparian zones are defined as areas adjacent to streams, lakes, and wetlands that support native vegetation adapted to saturated or moderately saturated soil conditions. When there is adequate mature vegetation, stable land-form, and large woody debris, riparian areas perform the following functions:

- Dissipate stream energy and erosion associated with high flow events.
- Filter sediment, capture bedload, and aid in floodplain development.
- Improve flood water retention and groundwater recharge.
- Develop diverse ponding and channel characteristics that provide habitat necessary for fish and other aquatic life to spawn, feed, and find refuge from flood events.
- Provide vegetation litter and nutrients to the aquatic food web.
- Provide habitat for a high diversity of terrestrial and aquatic biota.
- Provide shade and temperature regulation.
- Provide adequate soil structure, vegetation, and surface roughness to slow and infiltrate stormwater delivered as precipitation or low velocity sheet flow from adjacent areas (Prichard et al., 1998).

2.5.1 Inventory and Assessment

The objective for riparian area assessment and management is to protect, maintain, and restore mature native vegetation cover that provide the above functions and structures. See sections 2.4: Wetlands, 2.6: Floodplains, and Chapter 4: Vegetation Protection, Reforestation, and Maintenance for assessing the extent and quality of riparian management areas (RMA) in various settings.

Riparian Management Areas

Adequately sized and maintained riparian management areas are necessary for protecting streams, lakes, and wetlands from many of the impacts of surrounding urbanization.

2.5.2 Management

RMAs are used to buffer streams, lakes, wetlands and other aquatic resources from adjacent land disturbance. While managing RMAs to maintain vegetation cover, soils, and stable land-form to buffer aquatic resources is standard practice, managing overland stormwater flows from adjacent developed is not the primary function of riparian management areas. However, if the riparian area will receive storm flow, the following minimum riparian buffer design criteria are recommended to dissipate, infiltrate, and remove pollutants from overland flow:

- Maintain overland flow as sheet flow and do not allow stormwater entering or within buffers to concentrate.
- Maintain (and restore if necessary) mature, native plant community and soils within the buffer.
- Designate buffer widths consistent with best available science (see Washington State Department of Community, Trade and Economic Development *Critical Areas Assistance Handbook,* 2003 and *Citations of Recommended Sources of Best Available Science,* 2002).
- If buffer averaging is used, the following minimum site features and objectives should be considered when determining the extent of the buffer: soils, slope, vegetation, pollutant loads, water quantity and quality targets, and sensitivity of resource.
- Map RMAs on all plans, and delineate with fencing to protect soils and vegetation from construction damage. Fencing should provide a strong physical and visual barrier of high strength plastic or metal and be a minimum of 3 to 4 feet high (see Ecology 2005 SMMWW BMP C103 and C104). Silt fencing, or preferably a compost berm, is necessary in addition to, or incorporated with, the barrier for erosion control.
- Install signs to identify and explain the use and management of the natural resource protection areas.
- Buffers should include 100-year floodplain, wetlands and steep slopes adjacent to streams, and the channel migration zone.
- Flow velocities reaching and within buffer areas should not exceed 1 ft/second.
- Unrestricted overland flow distance should not exceed 150 ft for pervious areas and 75 ft for impervious areas before reaching buffers (Schueler, 1995).
- See Chapter 7: Flow Modeling Guidance for detailed dispersion guidelines.
- Do not allow effective impervious surface within the buffer.
- Activity within the RMA should be limited to:
    - o passive, confined recreation (i.e., walking and biking trails) constructed from pervious surfaces.
    - o platforms for viewing streams, lakes, and wetlands constructed with techniques to minimize disturbance to soils and vegetation.
- Establish a long-term management entity and strategy to maintain or enhance the structural integrity and capacity of the buffer to protect water quality and habitat.

2.6 Floodplains

The objective for floodplain area assessment and management is to maintain or restore: (1) the connection between the stream channel, floodplain, and off channel habitat; (2) mature native vegetation cover and soils; and (3) pre-development hydrology that supports the above functions, structures, and flood storage.

2.6.1 Inventory and Assessment

The following steps, at a minimum, should be used to inventory and provide baseline conditions of the floodplain area:

- Identify the 100-year floodplain and channel migration zone.
- Identify active channel.
- Inventory composition and structure of vegetation within the floodplain area.

2.6.2 Management

- Map the extent of the 100-year floodplain or channel migration zone on all plans and delineate these areas on the site with fencing to protect soils and vegetation from construction damage. Fencing should provide a strong physical and visual barrier of high strength plastic or metal and be a minimum of 3 to 4 feet high (see Ecology 2005 SMMWW BMP C103 and C104). Silt fencing, or preferably a compost berm, is necessary in addition to, or incorporated with, the barrier for erosion control.
- See Section 2.5: Riparian Management Areas for additional management strategies.
- Install signs to identify and explain the use and management of the natural resource protection areas.

A project should not be considered low impact development if it is located within the 100-year floodplain or channel migration zone.

2.7 Site Mapping Process

Through the assessment process, map layers are produced to delineate important site features. The map layers are combined to provide a composite site analysis that guides the road layout and overall location and configuration of the development envelopes (see figures 2.1 and 2.2, following pages). See Chapter 3: Site Planning and Layout for details on utilizing assessment information for site design.

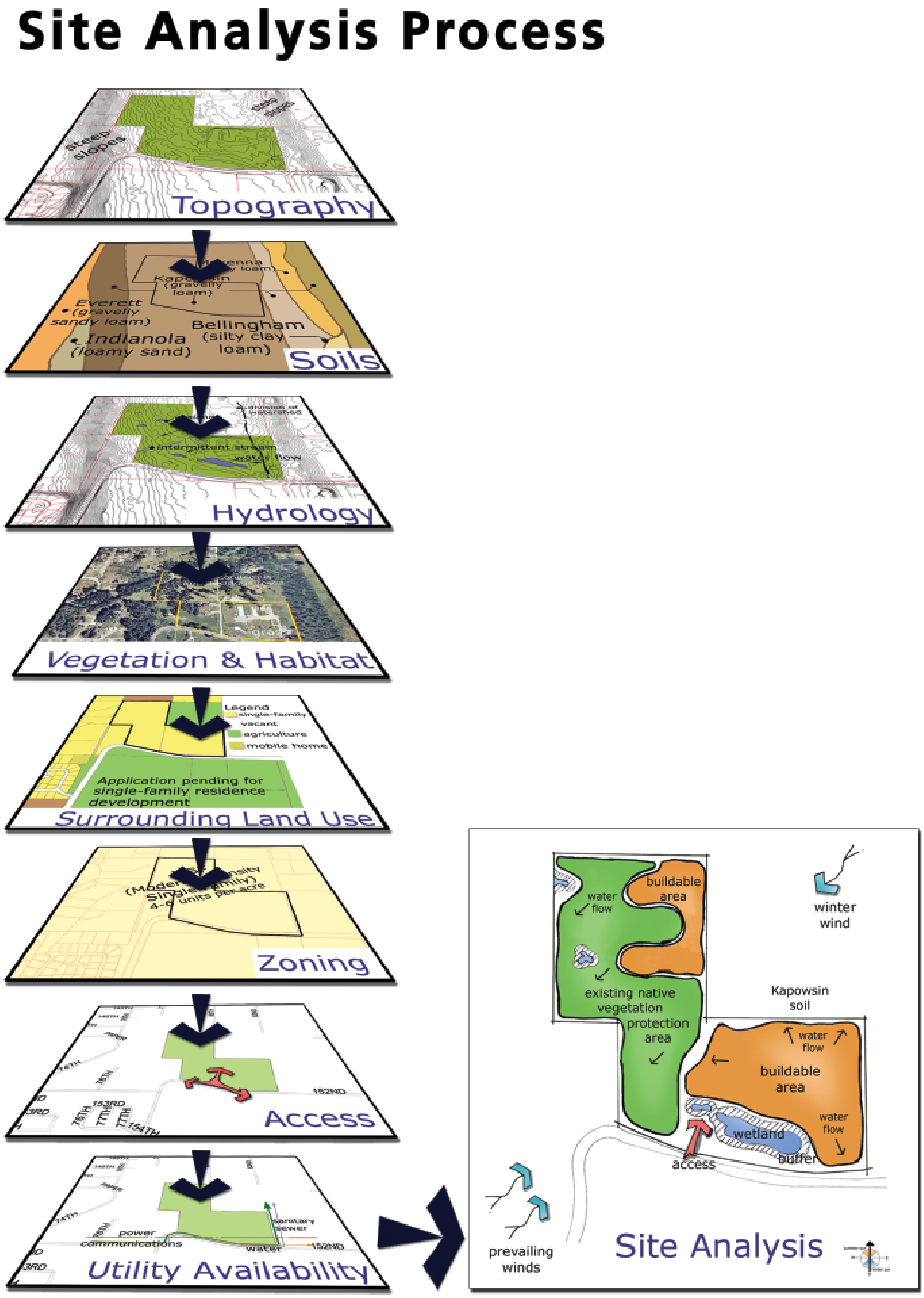

Figure 2.1 Composite site analysis for a residential subdivision.

Graphic by AHBL Engineering

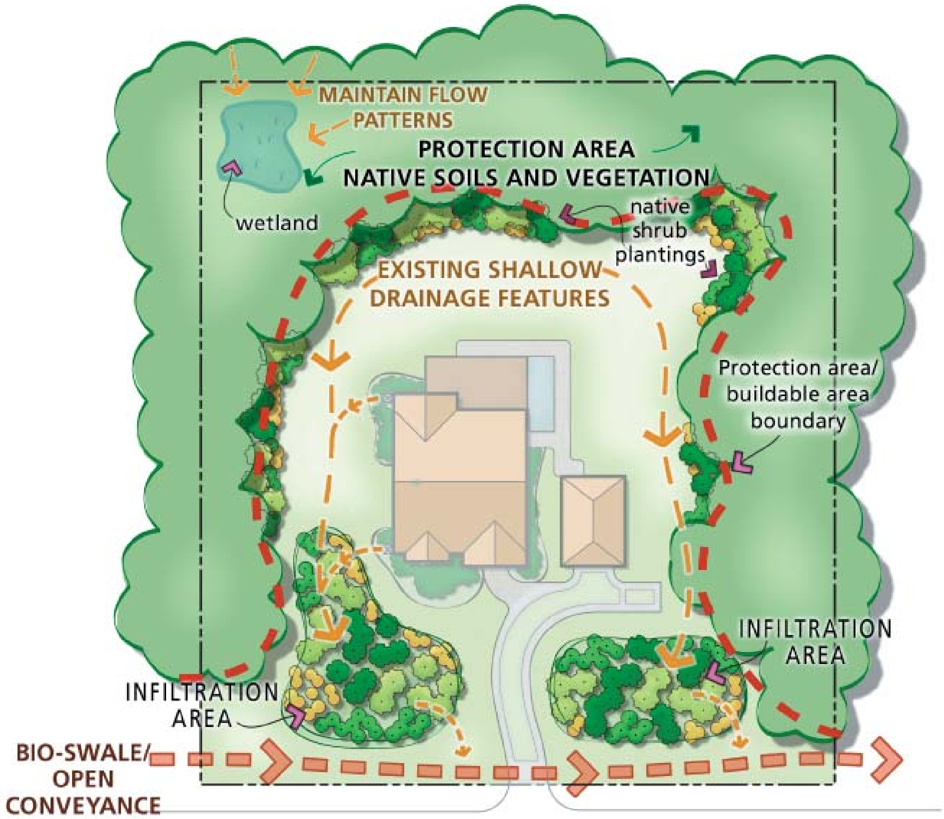

Figure 2.2 Large lot composite site analysis.

Graphic by AHBL Engineering